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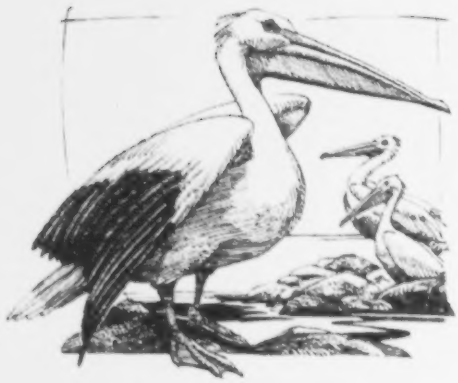
Survey of Colonial Nesting Birds and Lakeshore Habitats in Northeast Alberta



Alberta Species at Risk Report No. 88

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

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Survey of Colonial Nesting Birds and Lakeshore Habitats in Northeast Alberta

Christine Found and Anne Hubbs

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EXECUTIVE SUMMARY

The potential impacts on colonial nesting species and other waterbirds need to be addressed in light of increased industrial development, agricultural activity, and recreational opportunities within the northeast region of Alberta. Long-term monitoring and the assessment of species occurrence, productivity, and behaviour on a sample of lakes are key to determining the effects of habitat loss and alteration. In 2003, we monitored a large sample of lakes using a combination of aerial and boat survey techniques. We continued observations of previously surveyed lakes to delineate population trends, and began detailed analyses of lakeshore habitat. Nest counts, especially of Western and Eared Grebes, supplemented our knowledge of populations potentially at risk of decline due to human activities. We discovered that while some species were increasing in occurrence throughout the region, such as Double-crested Cormorants, others such as Western Grebes were less productive and occurred at lower numbers than historic levels. Overall, the species richness of waterbirds in the region was high, and indicated several lakes deserving of management attention including special signage and lakeshore protection. Continued monitoring of colonial species, other waterbirds, and their habitat is recommended.

1.0 INTRODUCTION

There has been a trend in the northeast (NE) region of Alberta towards increased industrial development, primarily as a result of expanding timber harvesting and oil and gas activities across the landscape (Northern Alberta Development Council 2003). This has resulted in several long-term and wide-ranging impacts on wildlife, including habitat modification and loss, effects of human disturbance, and a proliferation of access (Schneider et al. 2003). Also, NE Alberta is unique in its variety of habitats and juxtaposition of landscape types: the area between Lac La Biche and Athabasca represents the "fringe" between agricultural land to the south (i.e., "white zone"), and boreal forest to the north (i.e., "green zone"). This fringe is experiencing rapid modification as agriculture endeavours to expand, and recreationalists seek to access "untouched wilderness", including a variety of lakes available for fishing, camping, and cottage development. The impacts of human activity and development in this region have the potential to negatively affect populations of wildlife that are sensitive to disturbance, such as colonial nesting and other waterbird species (Brechtel 1981, Koonz and Rakowski 1985, Korschgen and Dahlgren 1992).

Colonial nesting species, including Western Grebe (*Aechmorphorus occidentalis*), Eared Grebe (*Podiceps nigricollis*), California Gull (*Larus californicus*), Common Tern (*Sterna hirundo*), Double-crested Cormorant (*Phalacrocorax auritus*), Great Blue Heron (*Ardea herodias*), and American White Pelican (*Pelecanus erythrorhychos*) nest in large groups on lake islands and sand bars, or within patches of emergent aquatic vegetation. The precarious nature of an aggregated breeding area makes colonial populations less resilient to the effects of habitat removal, excessive noise, or a direct interruption of nesting activities (Brechtel 1981, Ehrlich et al. 1992, Findholt and Diem 1988, Hanneman and Heckbert 2001, Koonz and Rakowski 1985, Semenchuk 1992). Therefore, several colonial nesting species have been listed as "sensitive" in Alberta, including Western Grebe, Great Blue Heron, Caspian Tern (*Sterna caspia*), Forster's Tern (*Sterna forsteri*), Black Tern (*Chlidonias niger*), and American White Pelican (Gutsell et al. 2000). These species may experience population declines as a result of unmitigated impacts, and therefore warrant special management attention.

Similarly, fish-eating raptors such as Bald Eagle (*Haliaetus leucocephalus*) and Osprey (*Pandion haliaetus*) react negatively to the use of pesticides, and their nesting areas may be negatively affected by shoreline clearing and other human activities (Ehrlich et al 1992, Semenchuk 1992). Therefore, both species of raptors and some waterfowl such as White-winged Scoter (*Melanitta fusca*) have been classified as "sensitive" according to the Alberta listing (Franken et al. 2002). Monitoring the productivity and abundance of waterfowl over time can provide a potential linkage to increased habitat loss and/or change (Kantrud 1986, McNicol et al. 1990). It is important to monitor the presence and relative abundance of species that are not necessarily at risk, since population trends are often indicative of other processes (such as habitat loss) occurring in natural systems (Johnson and Grier 1988).

Double-crested Cormorants, pelicans, and herons have been monitored annually in the NE Region for the past 10 years, with the focus more on disease surveillance (e.g., Newcastle's disease, Avian Botulism) than population trends. In 2001, an extensive boat and aerial monitoring program for colonial nesting and other waterbird species, including an initial assessment of lakeshore habitat, commenced in the Lac La Biche-Athabasca area. These surveys signalled the beginning of a long-term monitoring program for the region.

At the same time, a five-year study was initiated in central Alberta to study the distribution, population trends, and reproductive success of Western and Eared grebes, as well as to identify current knowledge gaps (Hanus et al. 2002 a, b). Results suggested that suitable nesting sites for Western grebes were limited and that the status of this species may be more vulnerable than previously believed. Eared grebes were restricted to lakes with little human activity and may be experiencing population declines from increased human encroachment into previously isolated areas. This research highlighted the need to initiate detailed grebe studies in other parts of the province, such as in the NE Region.

Therefore, in 2003 our survey efforts were more focussed and guided by the following objectives:

1) Continue to monitor primary populations of colonial nesting and other waterbird species by determining occurrence and relative abundance on previously and newly surveyed lakes;
2) Determine productivity of these species by noting the presence of breeding pairs, nests, eggs, and broods;
3) Map and analyse habitat information on shoreline features, disturbances, and emergent and backshore vegetation; and
4) Identify areas of particular concern to waterbirds that may warrant special management protection.

2.0 METHODS

2.1 Aerial Surveys

Surveys of lakes by fixed-wing aircraft (Cessna 180 or a Supercub) followed the Resources Inventory Committee (RIC) standards (Ministry of Environment, Lands and Parks, British Columbia 1998) for colonial-nesting freshwater birds. One continuous transect approximately 500 metres offshore (roughly between the shoreline and centerline of the lake) was flown for each lake. Smaller lakes for which opposite shorelines were both clearly visible from the aircraft were surveyed down the centerline. Flights focussed on determining the presence or absence, relative abundance, and breeding status (i.e., presence of nest or brood) of waterbirds, particularly Western Grebes and other colonial nesting species.

Fifty-two lakes in the region were flown in mid-late June, 2003 (Fig.1; Appendix 1). Eighteen of these lakes were known historically for Western Grebes (Hanus 2002), while an additional 23 lakes were known for Double-crested Cormorants (via the Fish and Wildlife Division cormorant program).

2.2 Boat Surveys

Since counting birds and observing whether they had broods or not was much more difficult from the air than from a boat, a detailed analysis on lake productivity, habitat, etc. was reserved for the boat-surveyed lakes. The protocol used for boat surveys also followed the RIC standards for colonials. Lakes were monitored using a canoe, kayak, small, motorized (15 or 25 hp) aluminium boat, or a larger, speedboat for the big waterbodies. On the larger lakes where motorized boats were used, there generally was a driver and two observers on each survey. We surveyed along a single transect approximately 100-400 metres from shore (depending upon shoreline vegetation and visibility) and noted birds between the shoreline and the centerline of the lake. Information recorded during surveys included: species, sex (based on plumage), and number of adults and young. On lakes where the water depth was too shallow for watercraft or when the waterbody was quite small, (i.e., Mons and Brayet lakes), a spotting scope was used for surveys.

Boat surveys focussed on a sample of 13 lakes originally surveyed for colonial nesting species in 2001, and on 18 other lakes throughout the NE Region where Western Grebe colonies have historically been identified (Fig.1; Appendix 1). There was some overlap between the aerial and boat-surveyed lakes. Of the sub-sample of lakes where Western Grebes were identified, only 13 of these underwent a full species survey using the standard protocol described above. Boat surveys occurred in the region from the end of May to mid-July, 2003.

Four additional lakes, identified through the Lakeland Industry and Community Association (LiCA) project (Nelson 2003), were surveyed by boat or with a spotting scope.

2.3 Nest Counts

Eared and Western grebe colonies located in June were re-visited once by boat in early to late July. Information collected included: total number of nests, mean clutch size, and number of active nests, using survey techniques from Hanus et. al. (2002b).

Nest counts of cormorants, gulls, Great Blue Herons, and pelicans were conducted on Portage, Antoine, Noral, and Lac La Biche lake colonies under a separate study (McGregor 2003). Additionally, the GPS location and occupancy of raptor nests in trees on the backshore were recorded as noted during all surveys.

2.4 Lakeshore Habitat Surveys

Habitat along lakeshores was recorded during boat surveys using a method developed from the "Cows and Fish" program within Alberta Sustainable Resource Development (L. Fitch pers. comm.). The shoreline was divided into transects based on changes in vegetation types or presence of man-made features. The start and end location of a transect was recorded by GPS. For each transect, the following information was recorded: emergent (e.g., sedge, cattails, bulrushes, etc.) or backshore vegetation, density and coverage of the vegetation (both on a scale of 1-5), substrate material (sand, gravel, etc.), beaver lodges, and human developments (e.g. buildings, beaches, trails, roads etc).

Lakeshore data was collected for all boat surveyed lakes in 2001, except Long Lake (Provincial Park), and for an additional 19 lakes in 2003. Preliminary estimates of percent shoreline disturbed and percent shoreline with emergent vegetation for thirteen lakes were calculated using ArcGIS. These estimates may change slightly once more detailed digital analyses are completed.

2.5 Lake Productivity

On lakes where a full species survey was conducted, an index of lake productivity was determined. The methodology used was based on calculations developed by NE Region biologists in the early '90s (J. Folinsbee pers. comm.). The index is obtained by adding index ratings and values for a number of lake properties including the ratio of shoreline to lake area, number of birds seen, and vegetation diversity (Appendix 2). Vegetation diversity was ranked according to the number of different substrate types and emergent vegetation species present along a shoreline. Lakes with a large amount of developed shoreline generally rated low for vegetation diversity. All waterfowl, colonial nesting species, raptors, and kingfisher were included in the total number and species counts. Riparian passerines such as red-winged blackbird and other incidental species (i.e., turkey vultures) were excluded from the analysis. In general, all observations of adults and their young were included under the totals. On Portage, Antoine, and Lac La Biche lakes, adult cormorants, pelicans (Portage Lake) and California Gull (Antoine Lake and Lac La Biche) were not counted during regular boat surveys. However the total number of nests found on colonies for these species were included in the totals to provide a conservative estimate of adults present.

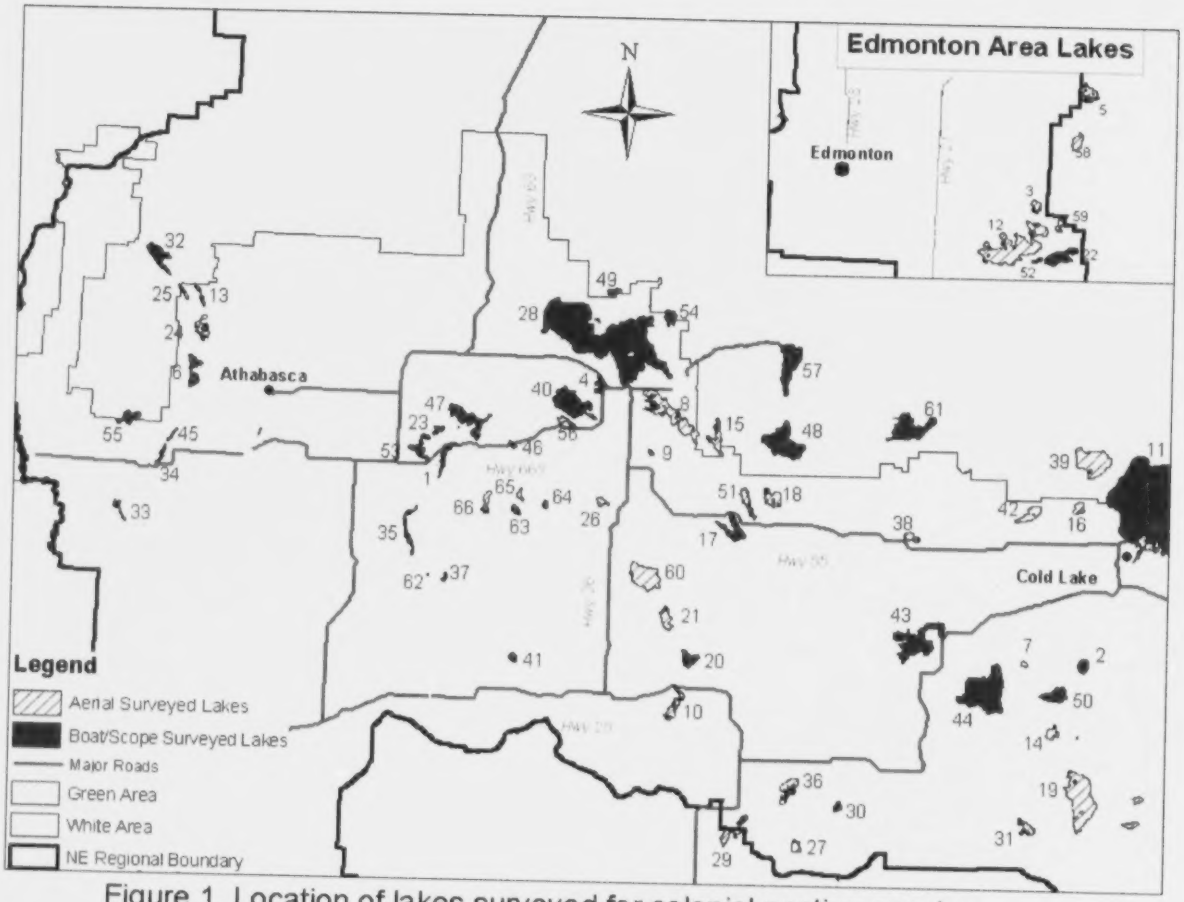

Figure 1. Location of lakes surveyed for colonial nesting species and other waterbirds in the Northeast Region, 2003 (see Appendix 1 for lake names and geographic locations).

3.0 RESULTS

(All raw data results for this project have been stored in paper and digital files within the Lac La Biche/Athabasca Area office.)

3.1 Aerial Surveys

Aerial surveys of 52 lakes indicated that most waterbodies accommodated several waterbird, waterfowl, and other bird species, including various ducks, gulls, grebes, common loons, and raptors (Table 1). Many species were noted as "breeding" (young or nests), including Red-necked Grebe, American Coot, Common Loon, Canada Goose, Common Merganser, Bald Eagle, and Osprey. In terms of colonial nesting species, Great Blue Herons were observed nesting on Astotin, North Buck, Frog, Hastings, Moore, and Whitefish Lakes, while colonies of gulls were seen on Muriel Lake and Lac La Biche. Caspian Terns were noted nesting on Lac La Biche, along with Common Terns, gulls, and Double-crested Cormorants. Cormorant colonies were also noted on Astotin, Frog, Muriel, Antoine, Kerr, Noral, Portage, and Whitefish lakes. Black Terns were sighted relatively often, while Forster's Terns were not seen from the air. Western Grebes were noted on six (Cold, Frog, Hastings, Lac La Biche, Angling, and North Buck) of 18 historical lakes, and on one unnamed lake encountered during flights for cormorants. However, breeding activity was noted on only two waterbodies (Cold and Hastings). Eared Grebes were not detected on any of the lakes surveyed.

3.2 Boat Surveys

Boat surveys provided more information than aerial surveys in terms of specific species presence and their breeding status (Table 2). Many ducks were observed with broods on the lakes; common goldeneye and mallard seemed especially common. Nests of Bald Eagle and Osprey were observed along lakeshores, and Red-necked Grebe and Common Loon were also very common breeders. Colonies of California Gull, Double-crested Cormorant, Common Tern, Eared Grebe, Great Blue Heron, Western Grebe, American White Pelican, and Forster's Tern were observed on several lakes. Assemblages of co-nesting colonial species, such as gulls and cormorants, cormorants and pelicans, or terns and gulls, were noteworthy on Antoine, Fork, Lac La Biche, Noral, and Portage lakes.

Western Grebes were observed on 9 of 35 lakes surveyed by boat or with a spotting scope while Eared Grebes occurred on 12 lakes (Tables 2 and 3). The largest Western Grebe populations occurred on Lac La Biche, Cold, and Muriel Lakes with greater than 450 adults on each lake. Hastings Lake and Barbara Lake had sizeable Eared Grebe populations. Although most surveys occurred prior to the hatching period, successful breeding (i.e., presence of young) was confirmed on Lac La Biche, Muriel, and Moose for Western Grebes and on Lac La Biche and Barbara for Eared Grebes.

Table 1. Summary of waterbird, waterfowl, and other bird species[a] occurrence from lakes surveyed by air in 2003.

Lake Name[b]	Waterbirds	Waterfowl	Other Birds
Lake #8 (unnamed)	**RNGR**	(DUCKS)	
Angling Lake	COLO, RNGR, AWPE, AMCO, WEGR		
Antler Lake	(GULLS), **RNGR**	(DUCKS), MALL	
Astotin Lake	**DCCO**, AWPE, (GULLS), **AMCO**, **RNGR**, **GBHE**	(DUCKS)	
Beartrap Lake	RNGR, GBHE, COLO, DCCO, AWPE	(DUCKS)	
Cache Lake	**RNGR**		
Cold Lake	**WEGR**, **RNGR**, GBHE, COLO, AWPE, COTE, **COME**	**CAGO**, (DUCKS)	**BAEA**
Cooking Lake	(GULLS), GBHE, BLTE, AMCO	(DUCKS), LESC, CAGO, CITE, MALL	
Cushing Lake		**CAGO**	
Elinor Lake	RNGR, AWPE, COLO	(DUCKS), TPSW	**OSPR**
Ethel Lake	**RNGR**, COLO, GBHE, AWPE, BLTE		**OSPR**
Frenchman Lake	**RNGR**, COLO	(DUCKS)	
Frog Lake	**DCCO**, AWPE, **GBHE**, COLO, **RNGR**, WEGR	**CAGO**	
Goodfish Lake	**RNGR**, COLO, AWPE		BAEA, OSPR
Hastings Lake	**GBHE**, AWPE, (GULLS), **WEGR**, **AMCO**, **RNGR**	**CAGO**, (DUCKS)	
Lac Bellevue	RNGR, AWPE, COLO	WWSC, (DUCKS)	
Lac Sante	AWPE, GBHE, RNGR, DCCO, BLTE, COLO		
Lac St. Cyr	COLO, RNGR, AWPE, (GULLS)	(DUCKS & **GEESE**)	
Laurier / Borden Lake	**RNGR**, RNGR, DCCO, AWPE, GBHE, (GULLS)	RHDU, CANV, **CAGO**	
Lower Therein Lake	COLO, AWPE, DCCO, RNGR, (GULLS)	WWSC, MALL, COGO	
Manatoken Lake	AWPE, RNGR, GBHE, (GULLS)		
Marie Lake	RNGR, AWPE, COLO, GBHE		OSPR, **BAEA**
Moore (Crane) Lake	RNGR, AWPE, COLO, **GBHE**		OSPR
Muriel Lake	**RNGR**, COTE, BLTE, GBHE, **DCCO**, CAGU, RBGU, **HEGU**	**CAGO**	
Reita Lake		PINT, MALL, **CAGO**	

Rich Lake		**CAGO**, (DUCKS)	
Sissib Lake		(DUCKS)	
Towayak Lake		(DUCKS), RUDU, MALL, LESC	
Wanison Lake	GBHE	(DUCKS), LESC, MALL	
Lake Name[c]	Waterbirds	Waterfowl	Other Birds
54 22/112 37 (unnamed)		(DUCKS)	
54 29/112 21 (unnamed)	**RNGR**, AWPE, COLO, DCCO	(DUCKS), **CAGO**	
54 30/112 16 (unnamed)	(GREBES), BLTE, (GULLS), RNGR	(DUCKS)	
54 31/112 22 (unnamed)	DCCO, (GULLS), BLTE, WEGR, RNGR	(DUCKS)	
54 31/112 27 (unnamed)	AWPE, DCCO, BLTE, RNGR, GBHE, COLO	(DUCKS), **CAGO**	
Amisk Lake	COLO, (GREBES), GBHE, (TERNS), COTE, RNGR	(DUCKS)	
Antoine Lake	(GULLS), COLO, GBHE, **DCCO**, AWPE, RNGR, BLTE, AMCO	(DUCKS), **CAGO**	
Beaver Lake	AWPE, RNGR, COTE, COLO, (GULLS), DCCO	(DUCKS), **CAGO**	BAEA
Fork Lake	AWPE, COTE, **RNGR**, (GULLS), BLTE, **COLO**, DCCO	(DUCKS)	BAEA
Island Lake	AWPE, COLO, BLTE, GBHE, RNGR, (TERNS)	(DUCKS)	BAEA
Jenkins Lake	AWPE, COLO	(DUCKS)	
Kerr Lake	RNGR, **DCCO**, COLO, BLTE, (GULLS)	**CAGO**, RUDU	BAEA
Lac La Biche	**COTE**, **CATE**, AWPE, GBHE, **(GULLS)**, **DCCO**, RNGR, COLO, **WEGR**	(DUCKS), CAGO	OSPR, BAEA
Long Lake	COLO, (GREBE), GBHE	(DUCKS), CAGO	
Lucky Lake	COLO	(DUCKS)	
Missawawi Lake	GBHE, BOGU, DCCO, **(GREBES)**, COTE, AMCO, COLO, AWPE	**RHDU**	
Noral Lake	**DCCO**, RNGR, BLTE	(DUCKS), **CAGO**	
North Buck Lake	**GBHE**, AWPE, COLO, (GULLS), WEGR, (TERNS), RNGR	MALL, CAGO	
Portage Lake	**AWPE**, BLTE, **DCCO**	(DUCKS)	
Skeleton Lake	AWPE, COLO, COTE, RNGR, (GULLS), BLTE	MALL, CAGO	BAEA
Square Lake	GBHE, AWPE, RNGR, (TERNS), (GULLS), COLO,	(DUCKS)	BAEA

	DCCO		
Tawakwato Lake	DCCO, GBHE, (GULLS), RNGR, BLTE, AMCO, AWPE	**CAGO**, (DUCKS)	
Whitefish Lake	AWPE, (GULLS), **DCCO**, RNGR, BLTE, COTE, **GBHE**	(DUCKS)	

[a] See Appendix 3 for species names.
[b] These lakes flown primarily for western grebes (NAWMP).
[c] These lakes flown primarily for double-crested cormorants (Lac La Biche Fish and Wildlife Division).

Table 2. Summary of lakes surveyed by boat or spotting scope for all waterbird, waterfowl, and other bird species[a] in 2003.

Lake Name	Waterbirds	Waterfowl	Other Birds
Amisk Lake	AMWP, GBLH, BLTE, DCCO, **RNGR**, **COLO**, COME,	**COGO**, MALL, GADW, AMWI, BWTE, GWTE, LESC, BUFF, RNDU	OSPR, GOEA, RTHA
Antoine Lake	AMWP, **CAGU**[b], GBLH, COTE, BLTE, **DCCO**[b], **RNGR**	**COGO**, MALL, BWTE, GWTE, LESC, RHDU, **BUFF**, RUDU, RNDU	BAEA, RTHA, NOHA
Baptiste Lake	AWPE, BLTE, FRGU, RNGR, **COLO**, AMCO	**COGO**, **MALL**, AMWI, LESC, RNDU, **CAGO**	OSPR, **BAEA**
Brayet Lake	EAGR, PBGR, AMCO	COGO, MALL, BWTE, LESC, RHDU, BUFF, RUDU	AMKE
Crooked Lake	GBLH, FRGU, AMWP, **COLO**, **RNGR**, PBGR	AMWI, **MALL**, BWTE, GWTE **COGO**, **CAGO**, BUFF, RNDU, CANV, LESC	**BAEA**, OSPR
Fork Lake	AWPE, GBLH, **COTE**[b], BLTE, **BOGU**, **CAGU**[b], DCCO, **RNGR**, **COLO**, AMCO	COGO, MALL, GADW, AMWI, GWTE, GWTE, LESC, RHDU, BUFF, RUDU, NOSV, **CAGO**	OSPR, RTHA
Garner Lake	AWPE, COTE, BLTE, BOGU, FRGU, CAGU, DCCO, **RNGR**, COLO, COME, AMCO	COGO, MALL, AMWI, BWTE, GWTE, LESC, RHDU, BUFF, CANV, NOSV, RNDU, CAGO	OSPR
Hastings Lake	AWPE, **GBLH**, BLTE, FRGU, RBGU, DCCO, RNGR, WEGR, **EAGR**[b], HOGR, COLO, COME, AMCO	COGO, MALL, GADW, AMWI, BWTE, BWTE, LESC, RHDU, BUFF, RUDU, CANV, NOSV, WWSC, CAGO	RTHA
Hope Lake	GBLH, **RNGR**, COLO, AMCO	**COGO**, MALL, GADW, AMWI, BWTE, LESC, RHDU	OSPR, RTHA
Lac La Biche	AWPE, **GBLH**[b], COTE, **BLTE**[c], CATE, FRGU,	**COGO**, **MALL**, GADW, AMWI, **BWTE**,	BEKI, OSPR, **BAEA**,

	CAGU[b], **DCCO**[b], **RNGR**, **WEGR**[b], **EAGR**[b], **PBGR**, COLO, COME, RBME, AMCO	**LESC**, **RHDU**, **BUFF**, **RUDU**, **CANV**, NOPI, **NOSV**, WWSC, CAGO	GOEA, TUVU, NOHA, **RTHA**
Lawrence Lake	AWPE, GBLH, FRGU, DCCO, RNGR, **COLO**, AMCO	**COGO**, MALL, GADW, AMWI, BWTE, LESC, BUFF, WWSC, CAGO	OSPR, BAEA, TUVU
Long Island Lake	GBLH, RNGR, COLO	**MALL**, **LESC**, BUFF, CAGO	OSPR
Long Lake	GBLH, BLTE, **RNGR**, PBGR, **COLO**	COGO, **MALL**, AMWI, BWTE, LESC, BUFF	OSPR, BAEA
Long Lake (pk.)	GBLH, COTE, BLTE, BOGU, **RNGR**, COLO, AMCO	COGO, MALL, AMWI, BWTE, LESC	**OSPR**, RTHA
Missiwawi Lake	AWPE, GBLH, COTE, BLTE, **BOGU**[c], HGGU, DCCO, **RNGR**, WEGR, COLO, AMCO	**COGO**, **MALL**, BUFF, RUDU, WWSC	
Mons Lake	**RNGR**, EAGR, COLO	(DUCKS)	
Narrow Lake	GBLH, BLTE, BOGU, COLO	MALL, AMWI, BUFF, CAGO	BEKI, NOHA
Noral Lake	**GBLH**[b], BLTE, CAGU, **DCCO**[b], COLO	COGO, MALL, BWTE, **LESC**, BUFF, CANV, CAGO	BAEA
North Buck Lake	AWPE, GBLH, COTE, BLTE, BOGU, CAGU, DCCO, **RNGR**, **COLO**, COME, AMCO	COGO, MALL, AMWI, BWTE, GWTE, LESC, RNDU, RHDU, BUFF, CANV, WWSC	OSPR, **BAEA**, RTHA
Pinehurst Lake	AWPE, GBLH, COTE, **RNGR**, **COLO**, COME, AMCO	COGO, MALL, GADV, AMWI, BWTE, GWTE, LESC, RHDU, BUFF, RUDU, NOSV, CANV, NOPI, WWSC, CAGO	OSPR, BAEA, GOEA
Portage Lake	**AWPE**[b], GBLH, COTE, BLTE, RBGU, **DCCO**[b], **RNGR**, COLO, **CAGU**	**COGO**, MALL, GWTE, LESC, BUFF, RUDU, RNDU, WWSC, CAGO, GWFG	OSPR, BAEA
Skeleton Lake	AWPE, GBLH, COTE, BLTE, **RNGR**, **COLO**, COME, AMCO	**COGO**, **MALL**, AMWI, GWTE, LESC, BUFF, RUDU, NOSV, **CAGO**	OSPR, **BAEA**, SSHA
Square Lake	AWPE, GBLH, DCCO, **RNGR**, COLO	COGO, MALL, GADW, AMWI, GWTE, LESC, BUFF, WWSC	OSPR, BAEA
Steele Lake	GBLH, BLTE, BOGU, DCCO, **RNGR**, COLO	**COGO**, MALL, GADW, AMWI, BWTE, GWTE, LESC, BUFF, RUDU, WWSC, CAGO	**OSPR**, BAEA
Touchwood Lake	AWPE, BLTE, COLO, COME	**COGO**, **MALL**, AMWI, LESC, BUFF	**OSPR**, BAEA, GOEA
Wolf Lake	AWPE, GBLH, COTE, **BLTE**[c], **FOTE**[b], CAGU, RBGU, DCCO, **RNGR**, WEGR, EAGR, **COLO**, COME, AMCO	**COGO**, MALL, AMWI, BWTE, BWTE, LESC, BUFF, NOSV, RNDU, WWSC,	BEKI, OSPR, **BAEA**, GOEA, RTHA

[a] See Appendix 3 for species names.
[b] Colony–assemblage of young/nests.
[c] Colony not confirmed.

Table 3. Summary of Western and Eared Grebe data from 2003 boat and spotting scope surveys.

Lake Name	Survey Location	Survey Method	Survey Date	Western Grebes		Eared Grebes	
				# of Adults	Young Present [1]	# of Adults	Young Present [1]
Lac La Biche	Mission Bay	Partial Boat	8-Jun	400		0	
	Entire Lake	Meandering Boat	3,4, 7-Jul	511-560	Y	14	Y [2]
Cold	Long, Centre & French Bays	Partial Boat	24-Jun	450+		0	
	Entire Lake	Meandering Boat	13-Jul	325	Unknown	0	0
Wolf	Entire Lake	Meandering Boat	12-Jun	79+ [3]		1	
	Entire Lake	Meandering Boat	2-Jul	20		0	
Angling	Entire Lake	Aerial	24-Jun	60		0	
	Entire Lake	Meandering Boat	27-Jun	59		1	
	Entire Lake	Meandering Boat	8-Jul	26	N	2	N
Hastings	Entire Lake	Meandering Boat	6-Jun	45+		30+	
	West side	Partial Boat	26-Jul	14	N	915	N
Moose	Entire Lake	Meandering Boat	29-Jun	39		0	
	NW corner & Franchere Bay	Partial Boat	14-Jul	25	Y	0	N
Muriel	Entire Lake	Meandering Boat	26-Jun	331		0	
	South half	Partial Boat	6-Jul	760+	Y [4]	2	N
	SW corner & West side	Spotting Scope	19-Jul	305	N	0	N
Reita	Entire Lake	Meandering Boat	1-Jul	0		11	
Missiwawi	Entire Lake	Meandering Boat	22-Jul	30-55	N	0	N
Mons		Spotting Scope	19-Jul	0	0	1	N
Brayet		Spotting Scope	18-Jul	0	0	2	N
Barbara*	Entire Lake	Meandering Boat	11-Jul	0	0	261	Y
Barreye*	Part Lake	Spotting Scope	27-Jun	0		2	N
Ernestina*	Entire Lake	Meandering Boat	27-Jun	0		1	
Manatokan*	Entire Lake	Meandering Boat	27-Jun	1		0	

[1] A blank cell indicates "non-applicable" (surveys occurred before young typically hatch).

[2] 3 young in 2 broods. [3] Approximately 35 nests.

[4] Only 2 young were seen. * Surveyed by LICA crews.

3.3 Nest Counts

Western Grebe colonies were located on five lakes (Table 4). Two colonies on Lac la Biche had collectively 2306 nests for an estimated 4612 breeding adults. This represented 69% of the regional population of 6674 breeding adults. Approximately 400 western Grebes were also observed nesting at a third site on Lac La Biche (Mission Bay) in early June, but this site was abandoned by June 20th as an apparent result of high winds swamping nests (T. Maccagno pers. comm.). Cold Lake supported the second largest Western Grebe colony with 991 nests for an estimated 1982 breeding adults (30% of the regional population). Western Grebe colonies on Wolf, Angling, and Hastings Lakes each had less than 20 nests and approximately 40, 30, and 10 breeding adults, respectively. Approximately 33% and 64% of nests were active at the NE and NW colonies at Lac La Biche, while 56% of nests were active at Cold Lake. Mean clutch sizes were 2.24 and 1.20 eggs/nest on the two Lac La Biche colonies and 2.11 eggs/nest on Cold Lake. All nests, but one, were abandoned on Wolf, Angling, and Hastings Lakes at the time of surveys.

Only two Eared Grebe colonies were located (Table 5). The first colony was located within the largest Western Grebe colony on Lac La Biche. Thirty-four Eared Grebe nests were present for an estimated 68 breeding adults with a mean clutch size of 2.75 eggs/nest. The second Eared Grebe colony occurred on Hastings Lake with 10 nests and on average, 1.60 eggs/nest.

Active raptor nests were noted on nine lakes surveyed by boat (Table 2). Three of these lakes had nests occupied by Osprey, and the remaining showed evidence of breeding activity by Bald Eagle. Nest counts of cormorants, gulls, Great Blue Herons, and pelican showed that high numbers of cormorant (>2000) and gull (>800) nests were present on High Island (LLB) and Antoine Lake (Table 6), while 385 pelican and 1526 cormorant nests were counted on the Portage Lake colony. Numbers of great blue heron nests were relatively low, upwards of 11 and 13 on High Island and Noral Lake, respectively.

Table 4. Summary of total nest counts for Western Grebes.

Lake Name	Colony Location	Survey Date	# of Nests Surveyed	# Active Nests (%) *	Nest Condition			Mean Clutch Size (± 1 SE) **
					# of Intact Nests	# of Partially Submerged Nests	# of Submerged Nests	
Lac La Biche	NW shore	10-Jul	2291	1470 (64.2%)	1702	511	78	2.24 ± 0.02
	NE Corner	25-Jul	15	5 (33.3%)	10	3	2	1.2 ± 0.2
Cold		11-Jul	237 / 389***	219 (56.3%)	178	36	125	2.11 ± 0.05
Wolf		14-Jul	20	0	14	5	1	0
Angling		8-Jul	15	1 (6.7%)	14	1	0	1.00 ± 0.0
Hastings		15-Jul	5	0	3	0	2	0

* Nests with ≥ 1 egg or chick, or egg fragments, at time of survey.

** Nests with ≥ 1 egg or chick at time of survey (e.g. 1 intact egg & 1 hatched egg = clutch of 2; 2 eggs & 1 chick = clutch 3). Egg fragments not included.

*** 991 total nests were counted but only a subset of nests were examined for eggs, chicks, or egg fragments (n = 389 nests) or recorded as intact or submerged (n = 339 nests).

Table 5. Summary of total nest counts for Eared Grebes.

Lake Name	Colony Location	Survey Date	# of Nests Surveyed	# Active Nests (%) *	Nest Condition			Mean Clutch Size (± 1 SE) **
					# of Intact Nests	# of Partially Submerged Nests	# of Submerged Nests	
Lac La Biche	NW shore	10-Jul	34	29 (85.3%)	25	9	0	2.75 ± 0.18
Hastings		15-Jul	10	3 (30%)	3	1	7	1.60 ± 0.60

* Nests with ≥ 1 egg or chick, or egg fragments, at time of survey.
** Nests with ≥ 1 egg or chick at time of survey (e.g. 1 intact egg & 1 hatched egg = clutch of 2; 2 eggs & 1 chick = clutch 3). Egg fragments not included.

Table 6. Nest counts of Double-crested Cormorants, gulls, Great Blue Herons, and pelicans on island colonies noted during boat surveys in 2003.*

	Colony				
	Antoine	**Portage**	**Noral**	**Pelican I. (LLB)**	**High I. (LLB)**
Date of survey	June 12	June 6	July 18	June 6	June 20
# DCCO nests	2344	1526	47	284	>2000
# Gull nests	~800	1	0	116	>800
# AWPE nests	0	385	0	0	0
# GBHE nests	0	0	13	0	>11

* Table adapted from McGregor (2003).

3.4 Lakeshore Habitat Surveys

Long, Pinehurst, Narrow, Wolf, and Lawrence lakes had <4% of shoreline disturbed by access points, beaches, cottages, and other developments (Table 7). Garner Lake had over half of its shoreline modified and nearly 40% of the shoreline surrounding Angling, Moose, Muriel, and Reita lakes was also disturbed. Emergent vegetation was relatively abundant (nearly 50% or more) on the shorelines of Ethel, Wolf, Angling, and Long lakes, while the amounts around Narrow, Muriel, Reita and Hastings lakes were all less than 20%. The percentage of shoreline disturbed and the amount of emergent vegetation were only weakly associated (Linear regression: r-square = 0.019; Fig. 2).

Table 7. Levels of habitat disturbance and development along shorelines surveyed by boat in 2003.

Lake Name	% Shoreline Disturbed	% Shoreline Emergent Vegetation
Long Lake	4	47
Pinehurst	2	32
Garner	55	38
Hastings	18	14
Lawrence	2	30
Narrow	<1	3
Wolf	3	69
Ethel	17	92
Moose	41	36
Beartrap	18	39
Muriel	38	17
Reita	44	0
Angling	42	53

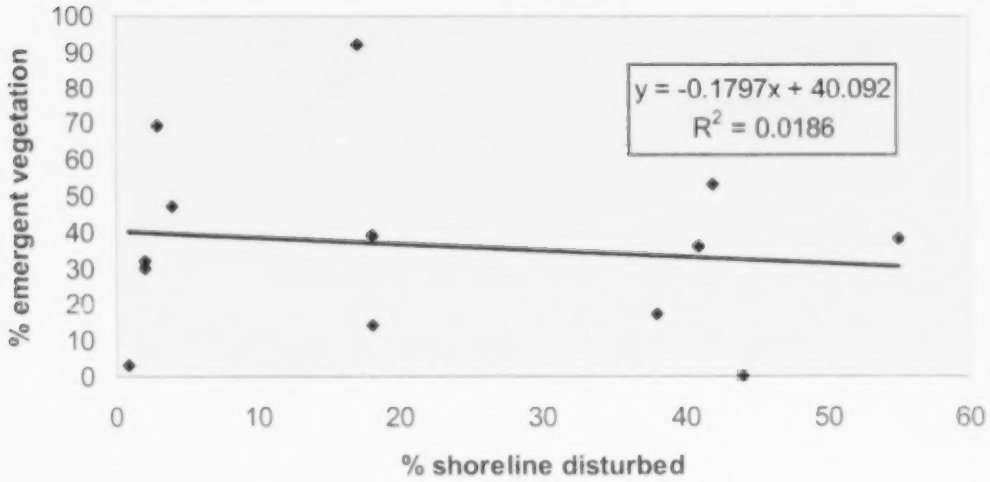

Figure 2. Comparison of percentage of shoreline disturbed versus with emergent vegetation for a sample of 13 lakeshore surveyed lakes.

3.5 Lake Productivity

The index of productivity of the boat-surveyed lakes varied from 5.8 to 14.9 (Table 8). Fourteen lakes were within the "good" range; the most productive lakes were Lac La Biche (14.3) and Hastings (14.9). It is noteworthy that these two lakes plus other high-rated waterbodies including Antoine, Portage, and Noral, all had significant colonies of colonial nesting species. Total number of birds seemed to significantly affect the index. Only one lake was rated as "poor" for productivity, Mons Lake, but it also had very few species of birds and low vegetation diversity. "Fair" lakes featured a wide variety of waterbodies including more protected areas (e.g., Steele and Touchwood Lakes) and those with extensive shoreline development (e.g., Skeleton and Lawrence Lakes).

Neither the percentage of shoreline disturbed nor the amount of emergent vegetation was a good predictor of the number of individual birds seen (Linear regression: r-squared = 0.004 and 0.016, respectively; Fig. 3). These factors were also poor predictors of the number of species per lake (r-squared = 0.091 and 0.167 for shoreline disturbed and emergent vegetation, respectively; Fig. 4).

Table 8. Productivity of lakes surveyed by boat in 2003.

Lake	Area (km^2)	Shoreline (km)	Max. Depth (m)	# Species	# Birds	Vegetation Diversity	Productivity Rating
Amisk	5.27	25.84	27.5	19	283	2	**8.8 (fair)**
Antoine	3.96	17.98	10[c]	19	3355[a]	3	**13.2 (good)**
Baptiste	9.72	27.34	27.4	14	383	2	**8.5 (fair)**
Brayet	0.93	4.50	1.4	11	162	3	**10.2 (good)**
Crooked	2.42	15.36	8.0	18	607	3	**11.3 (good)**
Fork	13.91	40.64	15.2	24	1704	3	**11.7 (good)**
Garner	7.75	20.89	15.2	24	393	3	**10.2 (good)**
Hastings	8.74	35.86	7.3	28	1941	5	**14.9 (good)**
Hope	2.76	9.58	15.5	13	173	2	**7.4 (fair)**
Lac La Biche	236.67	169.44	24.4	37	10 257[b]	5	**14.3 (good)**
Lawrence	13.93	25.95	17.6	19	725	4	**9.8 (fair)**
Long Island	2.21	18.62	13.0	8	67	4	**10.5 (good)**
Long	1.75	16.44	28.0[d]	13	72	3	**9.8 (fair)**
Long (pk.)	6.51	30.52	9.0[d]	14	270	2	**8.6 (fair)**
Missiwawi	26.39	43.81	5.0	16	1530	3	**10.6 (good)**
Mons	2.73	6.42	6.7	4+	128	2	**5.8 (poor)**
Narrow	1.18	9.51	36.6	10	51	2	**8.1 (fair)**
Noral	0.77	4.38	1.0[c]	13	330	2	**12.0 (good)**
North Buck	20.69	56.23	9.5	25	553	5	**11.5 (good)**
Pinehurst	39.54	51.82	23.5	25	771	4	**10.5 (good)**
Portage	2.37	11.18	3[c]	20	2095[e]	2	**13.1 (good)**
Skeleton	8.78	24.87	16.8	21	529	3	**9.9 (fair)**
Square	6.27	12.82	36.6	15	328	3	**8.2 (fair)**
Steele	7.22	19.02	6.4	19	506	3	**9.2 (fair)**
Touchwood	28.89	38.04	39.6	12	331	2	**6.3 (fair)**
Wolf	31.37	53.38	38.3	29	814	4	**10.6 (good)**

[a]Includes colony nest count of California gulls and double-crested cormorants on June 12, 2003 (no adult birds counted). Otherwise total number of birds is 211.

[b]Includes colony nest count of California gulls and double-crested cormorants on June 6 & 20 (under-represented (gulls) or no (cormorants) adults counted). Otherwise total number of birds is 7013.

[c]Approximated from experience boating on lake.

[d]Source: Mitchell, P., and E. Prepas. 1990. *Atlas of Alberta Lakes*.The University of Alberta Press, Edmonton, Alberta.

[e]Includes colony nest count of California gulls, double-crested cormorants, and American white pelicans on June 6 (no adult birds counted). Otherwise total number of birds is 183.

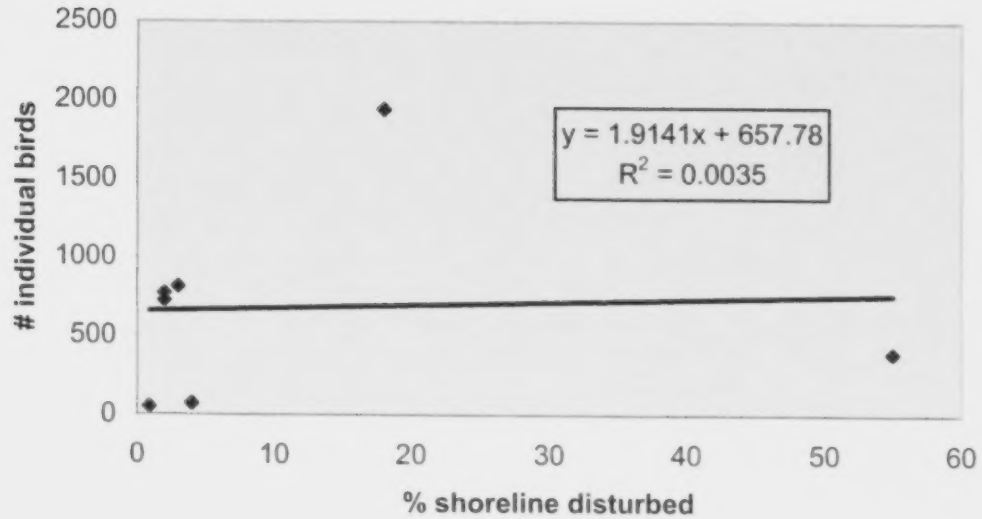

Figure 3. Comparison between shoreline composition and total number of birds seen on 7 lakeshore surveyed lakes.

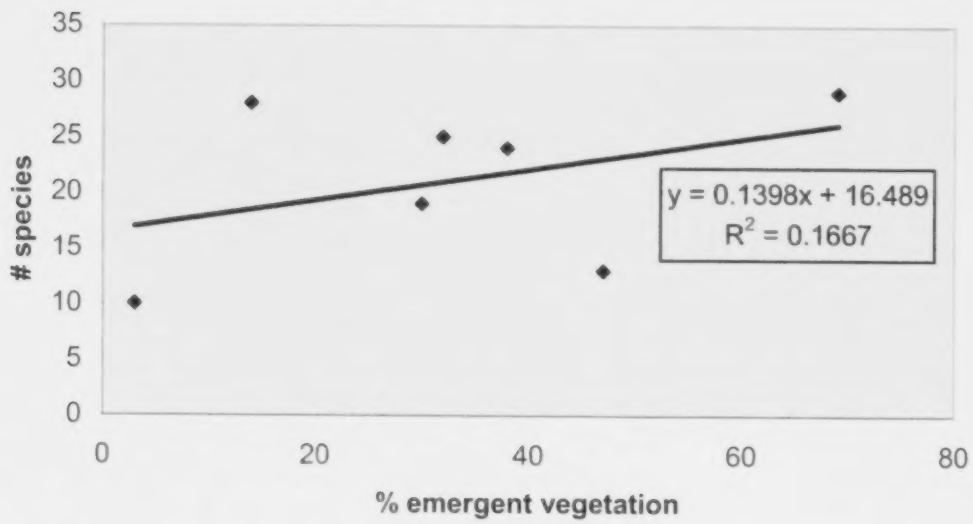

Figure 4. Comparison between shoreline composition and total number of species seen on 7 lakeshore surveyed lakes.

4.0 DISCUSSION

Aerial surveys provide an efficient method for surveying many lakes over a short period of time and the chance of "double-counting" the same birds is minimal. However, the accuracy of this method is compromised by the high speed and altitude of the aircraft. Highly visible species such as pelicans are noted more often than smaller, darker-coloured birds or those with discrete behaviours. During our survey, although many different waterbirds were noted, it was difficult to differentiate waterfowl species, gulls, and grebes. Since there was less of an opportunity to "double check" a sighting while in the aircraft, some sightings were missed or could not be confirmed. Aerial surveys underestimated the number of Western Grebe nests at the largest colony on Lac La Biche by 56%, despite the aerial survey occurring only one day after ground nest counts. Although uncommon, occasional large numbers of diving colonial species may be overlooked during aerial surveys. For example, no Western Grebes were observed during an aerial survey on Muriel Lake in late June while over 300 birds were seen during boat surveys 2 days later. Also, aerial surveys failed to detect Great Blue Herons nesting with Double-crested Cormorants on Noral Lake, although in this case the discrepancy in timing between the aerial survey (end of June) and the boat survey (5 weeks later) may have been responsible for the observed difference. Overall, aerial surveys are generally a good way to prioritize lakes and identify colonies that should be checked more carefully by boat, but are probably not as reliable as boat surveys for conducting a full species survey.

The boat survey results confirmed that several species of ducks and geese, gulls, terns grebes, fish-eating raptors and other colonial nesting species occur on the lakes in this Region. Many of these species, including Bald Eagle, Western Grebe, and Black Tern, are listed as "sensitive" (Gutsell et al. 2000), reflecting the Important Bird Area (IBA) status of Lac La Biche, and the general significance of this Region for waterbird conservation. There may be a trend, however, towards species occurring on fewer lakes over time (Table 9). Common Tern, cormorant, gulls, grebes, and pelicans, for example, were less widely distributed across lakes we surveyed this summer compared to two years ago. This change may be due to a decline in local populations. More likely, however, it is due to movement between waterbodies of foraging birds, or differences in survey methods between years. Evidence of breeding by waterbirds on the same sample of lakes has not changed significantly, and reflects site fidelity and the suitability of these lakes as nesting and brood-rearing habitat year after year (Johnson and Grier 1988). For a full listing of species occurrence on lakes during the 2001-2003 boat surveys (for all species), see Appendix 4.

Table 9. Comparison of bird species occurrence/breeding status from boat surveys of 13 lakes in the Athabasca/Lac La Biche Area, 2001-2003.

Species	# Lakes Present[a]		Trend	# Lakes Breeding[b]		Trend
	2001	2003		2001	2003	
American White Pelican	10	9	⇩	1	1	⇔
Black Tern	4	10	⇧	0	0	⇔
Common Loon	11	12	⇧	7	8	⇧
Common Merganser	3	3	⇔	0	0	⇔
Common Tern	9	6	⇩	0	1	⇧
Double-crested Cormorant	9	7	⇩	3	3	⇔
Eared Grebe	0	0	⇔	0	0	⇔
Great Blue Heron	11	12	⇧	2	2	⇔
Gulls (Bonoparte's, California, Herring, Ring-billed, Franklin's)	12	11	⇩	2	2	⇔
Horned Grebe	1	0	⇩	0	0	⇔
Kingfisher	5	0	⇩	0	0	⇔
Pied-billed Grebe	1	2	⇧	0	0	⇔
Raptors (osprey, hawks, eagles, kestrels)	13	13	⇔	3	7	⇧
Red-Necked Grebe	12	12	⇔	11	11	⇔
Waterfowl (ducks, geese) and American coot	13	13	⇔	13	9	⇩
Western Grebe	1	0	⇩	0	0	⇔

[a] Comprises data from the following lakes: North Buck, Skeleton, Amisk, Long (pk.), Long, Baptiste, Crooked, Hope, Square, Fork, Noral, Portage, Antoine.
[b] Indicated by the presence of nests or young broods.

The boat surveys also showed that, despite the consistency of breeding activity on certain lakes, some species appeared more productive than others. For example, broods of Mallard and Common Goldeneye were seen more often than those of other waterfowl, and Red-necked Grebe appeared with young on almost all lakes where they occurred. Lac La Biche, Wolf, and Fork lakes had more breeding birds than Garner or Square lakes, so may be considered as more "productive" than other lakes. However, species differences in brooding and hatching times, or differences in early hatchling behaviour (i.e., hiding in emergent vegetation versus riding on the adult's back) may explain this discrepancy, especially since we conducted our surveys only once in early summer. Multiple surveys throughout the breeding period, as has been done by other agencies (M. Ranger pers. comm.), may be required to accurately define whether a lake is supplying suitable breeding habitat for a variety of different waterbird species, or for only a limited few.

In addition to gathering occurrence and productivity data, boat surveys and nest counts on colonies depicted some behavioural strategies for colonial nesting. Colony assemblages of species which nest together within the same defined area, such as on an island (i.e. "co-nesters"), are likely a mutualistic adaptation to avoiding predation and to increase foraging efficiency, possibly by serving as information centers (Koonz and Rakowski 1985). Pelicans, which nest together with cormorants on Portage and Lac La Biche lakes, have been observed parasitizing cormorants by stealing their fish (C. Davis pers. comm.). Also, the young of these two species will form rafts or gather in close proximity to one another, possibly as a protective strategy against predators such as adult gulls (pers. obs.). Co-nesting may also be due to competition between species for the same nesting habitat, which may result in the displacement of one species over another (Ehrlich et al. 1992, Hanneman and Heckbert 2001). This has been suggested as a occurring between Great Blue Herons and cormorants, where herons will eventually leave an island colony once cormorant numbers increase to a certain level. If so, the general increase in cormorant populations throughout the Region (Cottonwood Consultants Ltd. 2000) may affect populations of other colonial nesters. Several large colonies of Double-crested Cormorants, including those previously unconfirmed (i.e., on Whitefish Lake), were found during the aerial and boat surveys in 2003, and there was no evidence of them abandoning historic nesting sites. Whether the effects of co-nesting and species assemblages are negative or positive, long-term monitoring of colonies will be necessary to determine whether the decline or increase of one species is resulting in the opposite trend of the co-nesting species.

Western Grebes were observed on 12 of 69 lakes surveyed by air or boat, but only five lakes supported confirmed colonies. Young were observed on two lakes, but colonies could not be confirmed. Historically, colonies of Western Grebes have been found on the colonies confirmed in 2003, plus on Ethel, Frog, Garner, Moose, Muriel, North Buck, Reita, and Lac Sante Lakes. However, the number of breeding adults has declined from historic levels on eight of these, increased on one, and remained stable on three of these lakes (Table 10). Also, average clutch sizes at colonies in 2003 (1.20 to 2.24 eggs/nest) were markedly lower than those reported in other studies in North America, including from central Alberta (2.6 to 3.7 eggs/nest; Hanus et al. 2003). These trends warrant concern regarding the long-term persistence of Western Grebes in NE Alberta. Potential threats to Western Grebes may include changes in habitat composition, recreational activities, predators (e.g. corvids), and commercial fisheries (C. Davis pers. comm.). Lac La Biche currently supports the largest known breeding population of Western Grebes in the province, followed by Lesser Slave (3,742 –Eadie 2002), Cold, Utikima (1700[+] - Gendron et al. 2001), Wabumun (1300 –Hanus et al. 2003), Lac Ste. Anne (1106- Hanus et al. 2003), Isle (88- Hanus et al. 2003), Wolf, Angling, and Hastings Lakes. It is predictable that relatively large lakes would support some of the largest breeding populations of Western Grebes in Alberta.

Table 10. Historic information on breeding populations of western grebes on lakes in Northeast Alberta.*

Lake	Year	No. Breeding Adults [1]
Angling	1981	1680
	2003	***30***
Cold	1979	2000
	1983	500
	1985	508
	2003	***1982***
Ethel	1981	84
	1989	80
	2003	***Unknown***
Frog	1957	200
	1965	150
	1991	600
	2003	***No colony***
Garner	1985	102
	2003	***0***
Hastings	1990	225
	2003	***10***
LLB	1980	3124
	1981	3124
	1988	3000
	2003	***4612***
Moose	1990	400
	1991	400-600
	2003	***Unknown***
Muriel	1991	400-600
	2003	***Unknown***
North Buck	1991	65
	2003	***0***
Reita	1981	532
	2003	***0***
Lac Sante	1987	50
	2003	***0***
Wolf	1980	290
	1981	290
	1983	420
	1985	720
	1988	732

	1989	540
	2003	***40***

[1] Number of nests x 2 (total nest count data).

* Source for pre-2003 data: Hanus (2002).

Similarly, Eared Grebes were seen on 12 lakes in the region with only Lac La Biche and Hastings supporting colonies. Historically, Cooking, Cooking Lake South, and Marguerite Lakes had over 1000+ breeding adults on each lake (Hanus 2002); over 3000 adult grebes were seen during Cooking Lake South surveys in 2002 (Beyersbergen pers. comm.). Eared Gebes may utilize a network of waterbodies for breeding and shift sites between years (Hanus et al. 2002b). It is thus important to survey all suitable lakes to obtain accurate population estimates. Although additional lakes require surveying, the few Eared Grebe colonies that were detected and their small size warrants concern about the species status in NE Alberta. Average clutch sizes (1.6 to 2.8 eggs/nest) in the Region were also relatively low compared with those reported in earlier studies in North America (2.2 to 3.7 eggs/nest; Hanus et al. 2003). Clutch sizes for both Western and Eared Grebes may decline as the nesting season progresses (Hanus et al. 2003) and therefore, smaller clutch sizes in our study may have been simply an artefact of performing nest counts late in the nesting season.

The results of the lakeshore surveys suggest that there is little association between the amount of disturbed shoreline and the proportion of emergent vegetation available. This is unexpected, since it was assumed that shoreline development (disturbance) consequently led to the loss of natural features including offshore vegetation. The method used to calculate these proportions may have been too coarse to determine an accurate relationship. Similarly, there was little relationship between the lakeshore results and the total number of birds and species seen during the boat surveys. The index of lake productivity seemed to be influenced the most by these two latter variables. It may be that long-term monitoring is required to see a correlation between habitat loss/modification and population declines. The lack of a relationship may also indicate differences in species preference and/or tolerance for different amounts of vegetation and disturbance along lakeshores (Kantrud 1986). The amount of recreational activity on lakes (e.g., boating, fishing), which is indirectly linked to lakeshore development, may be more significant in affecting species presence and/or breeding on waterbodies, especially for those species sensitive to direct human disturbance.

5.0 MANAGEMENT IMPLICATIONS

This study has identified a number of lakes in northeastern Alberta that warrant special consideration and management attention. These include lakes with high waterbird productivity indices such as Lac La Biche, Hastings, Antoine, Portage, Noral, Fork, North Buck, Wolf, and Pinehurst Lakes. In addition to these lakes, colonies of sensitive species were also detected on Cold, Astotin, Frog, Muriel, and Whitefish lakes. Lac La

Biche and Cold Lake supported nationally significant populations of Western Grebes (i.e. > 500 nests or breeding adults; Poston et al. 1990).

Although the number and diversity of bird species was not related to shoreline development and emergent vegetation using 2003 data, long-term data is ultimately required to determine the association between lakeshore composition and populations of waterbirds. Previous research indicates that habitat alteration has negative impacts on colonial species (e.g. Koonz and Rakowski 1985; Riske 1976). It is recommended that one or a combination of the following methods be employed to protect lakes warranting special consideration: designate legislated wildlife sanctuary and/or important bird areas, apply protective notations, and employ public education and signage. Presently active colonies of great blue herons, white pelicans, and other colonial nesters should be protected from surface access (within one kilometre) and air access (below 650 metres), particularly during the breeding season (Brechtel 1981).

Future surveys should continue the monitoring program outlined in this study. It is important that this project and others that assess the occurrence, distribution, and productivity of colonial nesters and other waterbirds consider long-term monitoring where population parameters will be re-assessed after several years. In this case, we suggest that trends in the NE Region should be reanalyzed and reported after a five-year period. Analysis of lakeshore habitat should also continue with the creation of digital maps to increase the accuracy of habitat/population comparisons and to provide wildlife managers with an accurate representation of study lakes. Levels of recreational activity should be monitored to see what affect or role they play on the productivity and success of colonial species and other birds using lakes. This will enable wildlife professionals to provide land managers with accurate data on lakes, which may influence future land use decisions. In terms of Western and Eared Grebe research, recent surveys have been concentrated in the Stony Plain region, the northeast region (this project), and Lesser Slave Lake. Additional surveys are required in other regions (e.g. Parkland) to confirm the provincial status of this species and to identify lakes supporting colonies.

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Appendix 1. List of lakes surveyed by boat and fixed-wing in 2003.

Lake Number	Lake Name	ATS Reference (Township - Range)
1	Amisk Lake	64,65-18
2	Angling Lake	60-3
3	Antler Lake	52-21
4	Antoine Lake	66,67-14
5	Astotin Lake	54-20
6	Baptiste Lake	66,67-24
7	Beartrap Lake	60-4
8	Beaver Lake	66-12,13
9	Brayet Lake	65-13
10	Cache Lake	69-12
11	Cold Lake	63,64,65-1,2
12	Cooking Lake	51,52-21,22
13	Crooked Lake	68-24
14	Cushing Lake	58,59-3
15	Elinor Lake	65,66-11
16	Ethel Lake	64-3
17	Fork Lake	63-11
18	Frenchman Lake	64-10
19	Frog Lake	56,57-2,3
20	Garner Lake	60-12
21	Goodfish Lake	61-13
22	Hastings Lake	51-20
23	Hope Lake	65-18
24	Island Lake	67,68-24
25	Jenkins Lake	68-24
26	Kerr Lake	64-14
27	Lac Bellevue	56-9
28	Lac La Biche	67,68-13,14,15
29	Lac Sante	56-11
30	Lac St. Cyr	57-8,9
31	Laurier / Borden Lake	56-4
32	Lawrence Lake	69-25
33	Long Island Lake	63-25,26
34	Long Lake	64-25
35	Long Lake (pk.)	63-19
36	Lower Therein Lake	57-10
37	Lucky Lake	62-18
38	Manatoken Lake	63-7
39	Marie Lake	65-2,3
40	Missawawi Lake	66-15
41	Mons Lake	60-16

42	Moore (Crane) Lake	64-4
43	Moose Lake	60,61-6,7
44	Muriel Lake	59,60-5
45	Narrow Lake	65-24
46	Noral Lake	65-16
47	North Buck Lake	65,66-17,18
48	Pinehurst Lake	65,66-9,10
49	Portage Lake	69-14
50	Reita Lake	59-3,4
51	Rich Lake	64-11
52	Sisib Lake	51-21
53	Skeleton Lake	65-18,19
54	Square Lake	68-12,13
55	Steele Lake	65-25
56	Tawakwato Lake	66-15
57	Touchwood Lake	67,68-9,10
58	Tawayik Lake	53-20
59	Wanisan Lake	52-20
60	Whitefish Lake	62-13
61	Wolf Lake	66-6,7
62	54 22/112 37 (unnamed)	62-18
63	54 29/112 21 (unnamed)	63,64-16
64	54 30/112 16 (unnamed)	64-15
65	54 31/112 22 (unnamed)	64-16
66	54 31/112 27 (unnamed)	63,64-17

Appendix 2. Methodology for calculation of lake productivity.

(a) Area (km^2)		
(b) Shoreline length (km)		Enter data in cells outlined in red. All red cells must be filled to calculate the correct index.
(c) Degree of development		
(d) Degree of development rating		Note: Include shorelines of islands and major vegetated shoals in calculation of shoreline length.
(e) Maximum depth (m)		Degree of development calculates ratio of shoreline length to the circumference of a circle of the same area as the lake.
(f) 1/maximum depth		
(g) Number of species		
(h) Species/km of shoreline		
(I) Number of birds		
(j) Birds/km of shoreline		
(k) Birds/km of shoreline rating		
(l) Vegetation diversity		Rate on a scale of 1 to 5, where 1 = very limited emergent vegetation and few shoreline types; 5 = very diverse shoreline and vegetation types.
(m) Productivity Index (= line d+f+h+k+l)		
RATING	**#DIV/0!**	>6 = Poor; >6 < 10 = Fair; >10 <15 = Good; <15 = Exceptional

Appendix 3. Acronyms of bird names seen during 2003 surveys.

Acronym	Common Name	Scientific Name
AMCO	American Coot	*Fulica americana*
AMKE	American Kestrel	*Falco sparverius*
AMWI	American Wigeon	*Anas americana*
AWPE	American White Pelican	*Pelecanus erythrorhynchos*
BAEA	Bald Eagle	*Haliaetus leucocephalus*
BEKI	Belted Kingfisher	*Ceryle alcyon*
BLTE	Black Tern	*Chlidonias niger*
BOGU	Bonaparte's Gull	*Larus philadelphia*
BUFF	Bufflehead	*Bucephala albeola*
BWTE	Blue-winged Teal	*Anas discors*
CAGO	Canada Goose	*Branta canadensis*
CAGU	California Gull	*Larus californicus*
CANV	Canvasback	*Aythya valisineria*
CATE	Caspian Tern	*Sterna caspia*
CITE	Cinnamon Teal	*Anas cyanoptera*
COGO	Common Goldeneye	*Bucephala clangula*
COLO	Common Loon	*Gavia immer*
COME	Common Merganser	*Mergus merganser*
COTE	Common Tern	*Sterna hirundo*
DCCO	Double-crested Cormorant	*Phalacrocorax auritus*
EAGR	Eared Grebe	*Podiceps nigricollis*
FRGU	Franklin's Gull	*Larus pipixcan*
FOTE	Forster's Tern	*Sterna forsteri*
GADW	Gadwall	*Anas strepera*
GBLH	Great Blue Heron	*Ardea herodias*
GOEA	Golden Eagle	*Aquila chrysaetos*
GWFG	Greater White-fronted Goose	*Anser albifrons*
GWTE	Green-winged Teal	*Anas crecca*
HGGU	Herring Gull	*Larus argentatus*
HOGR	Horned Grebe	*Podiceps auritus*
LESC	Lesser Scaup	*Aythya affinis*
MALL	Mallard	*Anas platyrhynchos*
NOHA	Northern Harrier	*Circus cyaneus*
NOPI	Northern Pintail	*Anas acuta*
NOSV	Northern Shoveler	*Anas clypeata*
OSPR	Osprey	*Pandion haliaetus*
PBGR	Pied-billed Grebe	*Podilymbus podiceps*
RBGU	Ring-billed Gull	*Larus delawarensis*
RBME	Red-breasted Merganser	*Mergus serrator*
RHDU	Redhead	*Aythya americana*
RNDU	Ring-necked Duck	*Aythya collaris*
RNGR	Red-necked Grebe	*Podiceps grisegena*

RTHA	Red-tailed Hawk	*Buteo jamaicensis*
RUDU	Ruddy Duck	*Oxyura jamaicensis*
TPSW	Trumpeter Swan	*Cygnus buccinator*
WEGR	Western Grebe	*Aechmophorus occidentalis*
WWSC	White-winged Scoter	*Melanitta fusca*

Appendix 4. Summary of results from boat surveys done for waterbird, waterfowl, and some landbird species, 2001-2003.

	SPECIES[1]																		
LAKE	AWPE	BLTE	CATE	COLO	COME	COTE	DCCO	EAGR	FOTE	GBLH	(GULLS)	HOGR	BEKI	PBGR	(RAPTOR)	RBME	RNGR	(WATER)	WEGR
Antoine	1,3	3				1,3	1*,3*			1,3	1*, 3*	1			1,3		1*, 3*	1*, 3*	
Amisk	1,3	3		1*,3*	3	1	1,3			1,3	1		1		1*, 3		1,3*	1*, 3*	
Baptiste	1,3	1,3		1,3*		1				1	1		1		1,3*		1*,3	1*,3*	1
Beaver	2	2	2	2*		2*	2	2		2	2*				2*		2*	2*	2
Brayet								3						3	3			3	
Crooked	3			1,3*						1	3		1	3	1,3*		1,3*	1*,3*	
Elinor	2	2		2*		2				2	2			2	2*		2*	2*	
Figure				2				2*		2				2	2		2*	2*	
Fork	1,3	3		1*,3*		3*	3			1,3	1*,3*				1,3		1,3	1*,3*	1
Garner	3	3		3	3	3	3				3				3		3*	3	
Ghost	2			2*						2					2		2*	2*	
Hastings	3	3		3	3		3	3*		3*	3	3			3		3	3	3
Hope	1			1*,3		1				3	1				1,3		1*,3*	1*,3*	
Ironwood	2	2		2*		2*				2*	2*				2*		2*	2*	
Island	2	2		2*	2	2	2			2*					2*		2*	2*	
Jenkins	2			2	2*		2			2					2*			2*	
Kerr	2	2					2*	2			2*			2	2*			2*	
LLB	3	3	3	3	3	3	3*	3*		3*	3*		3	3*	3*	3	3*	3*	3*
Lawrence	3			3*			3			3	3				3		3	3*	
Long (pk.)	1	3		1,3		1,3	1			1,3	1,3				1*,3*		1*,3*	1*,3	
Long		3		1*,3*		1				1,3			1	3	1,3		1*,3*	1*,3*	
Long Island				3						3					3		3	3*	
Lucky	2	2		2			2	2									2*	2*	
Missawawi	3	3		3		3	3			3	3						3*	3*	3
Mons				3				3									3*	3	
Narrow		3		3						3	3		3		3			3	
Noral		1,3		1,3			1*,3*			1*,3*	1,3				1,3		1*	1*,3*	
North Buck	1,3	1,3		1*,3*	3	1,3	1,3			1*,3	1,3				1,3*		1*,3*	1*,3	
Pinehurst	3			3*	3	3				3					3		3*	3	
Portage	1*,3*	3		1*,3		3	1*,3*			3	1,3*				1,3		1*,3*	1*,3*	
Rich		2				2		2*			2				2			2*	
Skeleton	1,3	3		1*,3*	1,3	1,3	1			1,3	1				1*,3*		1*,3*	1*,3*	
Square	1,3	1		1,3	1		1,3			1,3	1		1		1*,3		1*,3*	1*,3	
Steele		2,3		2,3			3			3	2,3				2*,3*		2,3*	2*,3*	
Touchwood	3	3		3	3										3*			3*	
Wolf	3	3		3*	3	3	3	3	3*	3	3		3		3*		3*	3*	3

[1]Numbers (1,2,3) represent year of survey, i.e. 1= 2001, 2=2002, 3=2003.
*Evidence of breeding activity

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